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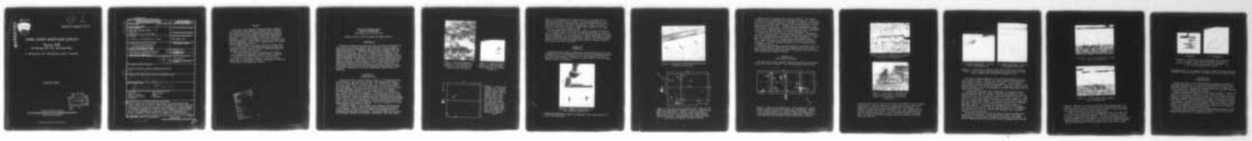

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Special Report 77-2

CRREL ROOF MOISTURE SURVEY

Pease AFB
Buildings 33, 116, 122 and 205

C. Korhonen, W. Tobiasson and T. Dudley

January 1977

CORPS OF ENGINEERS, U.S. ARMY
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Four building roofs at Pease AFB were surveyed with a hand-held infrared camera to detect wet insulation. Areas of wet insulation on these roofs were marked with spray paint, and 3-in.-diam core samples of the built-up membrane and insulation were taken to verify wet and dry conditions. Flashing defects are considered responsible for most of the wet insulation uncovered in this survey. Recommendations for maintenance, repair, and replacement were developed from the infrared surveys, core samples and visual examinations.

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PREFACE

This report was prepared by Charles Korhonen, Research Civil Engineer, Wayne Tobiasson, Research Civil Engineer, and Timothy Dudley, Civil Engineering Technician, Construction Engineering Research Branch, Experimental Engineering Division, U.S. Army Cold Regions Research and Engineering Laboratory. The work was funded by the USAF, Base Civil Engineering Division, 509th Combat Support Group (SAC), Pease AFB, New Hampshire, under Military Interdepartmental Purchase Request (MIPR) Number 15957.

Lt. Michael Suflita and Norman Turner of the Base Civil Engineering Division at Pease AFB participated in this work. Personnel from the Carpenter's Shop at Pease AFB patched the roofs where samples were obtained.

This report was technically reviewed by E.F. Lobacz, Chief, Construction Engineering Research Branch, USA CRREL.

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CRREL ROOF MOISTURE SURVEY
PEASE AIR FORCE BASE
Buildings 33, 116, 122 and 205

Charles Korhonen, Wayne Tobiasson and Timothy Dudley

INTRODUCTION

During the evening of 14-15 October 1976, the roofs of Buildings 33, 116, 122 and 205 at Pease AFB were surveyed with an infrared camera. Infrared photographs (thermograms) were obtained of light-colored (hot) anomalies on each roof. Suspected moisture-caused anomalies were outlined with white spray paint. The following day roof samples of the membrane and insulation were taken to verify infrared findings, conventional photographs were obtained, problem areas were examined for visual signs of distress, and dimensions were taken to locate the anomalies on plans of each roof. Water contents of all insulation samples were subsequently determined by oven drying at 110°F. This report covers the above work and also includes information on Building 116 obtained on 10 September 1975 as part of the roof research program CRREL is conducting for the Directorate of Facilities Engineering, Office, Chief of Engineers.

BUILDING 33
(Service Station)

Although the roof of this building is small, it has been problematic for many years. The roof is in two parts, the southerly half being about 1 ft lower than the northerly half. The northerly half consists of a steel deck, 1⅜ in. of perlite insulation, and a gravel-covered built-up membrane. According to samples taken by the U.S. Army Engineer Waterways Experiment Station (WES) for the Strategic Air Command, the southerly half consists of a concrete deck, ½ in. of insulation and a gravel-covered built-up membrane. The samples indicate that some moisture may have entered the insulation in the southern portion of the roof. Because of leaks, the membrane has been overcoated with aluminized bitumen over all of the northerly roof and over a portion of the southerly roof. Other portions of the southerly roof have been flood-coated with bitumen without the aluminized additive. The total thickness of the combined membrane varies from 1 to 1¼ in.

As shown in Figure 1, the surface of the aluminized roof is uneven and discolored. Surface texture differences are even more pronounced on the southerly portion of the roof where both aluminized and non-aluminized coatings have been applied. The thermal image of the roof is also confused, as shown in the Figure 2 thermogram. The light-colored

Figure 1. Daytime photograph of a portion of the northerly roof, Building 33. The arrow points to the location of sample A.

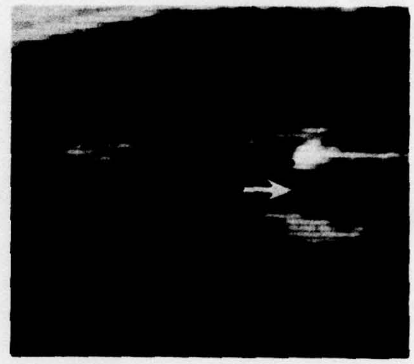


Figure 2. Nighttime thermogram of the area in Figure 1. Arrow points to the location of sample A.

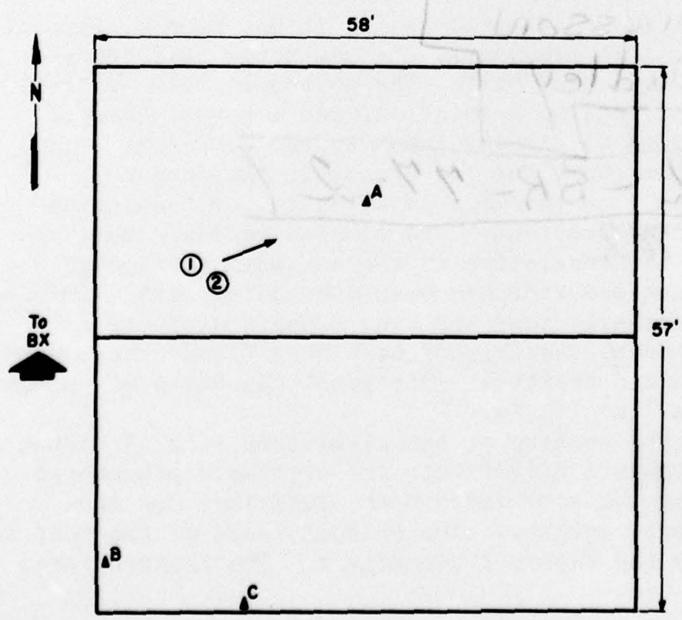


Figure 3. Plan view of Building 33. The water content of the insulation at sample A was 2%. Samples B and C were taken by WES in 1975. The WES samples indicate that some moisture may have entered the insulation in the southern portion of the roof. The arrow indicates the viewing direction and location of subjects in Figures 1 and 2.

areas on the thermogram could represent areas of wet insulation on a normal gravel-covered roof. However, the varying emissivity of the discolored aluminized coating on this roof is believed responsible for the blotchy nature of the roof's thermal image. Sample A, taken on this roof where shown in Figure 3, showed the insulation to be essentially dry. Its water content was 2%.*

It is understood that leaks persist. Based on a visual examination of the flashings and the fact that no large wet anomalies were detected by the infrared camera, it is felt that the leaks are probably associated with the flashings. It may be possible to resolve these leaks by careful examination and patching of the flashings. However, if such maintenance fails to stop the leaks, the membrane and insulation should be removed and replaced over the entire roof.

BUILDING 116
(Commissary)

Although there have been no significant problems with the roof of this building, past visual examinations by the base Civil Engineering Division and CRREL indicate that the membrane has a few blisters, felts are exposed along the perimeter, flashings need repair (Fig. 4), and two large membrane buckles are present.

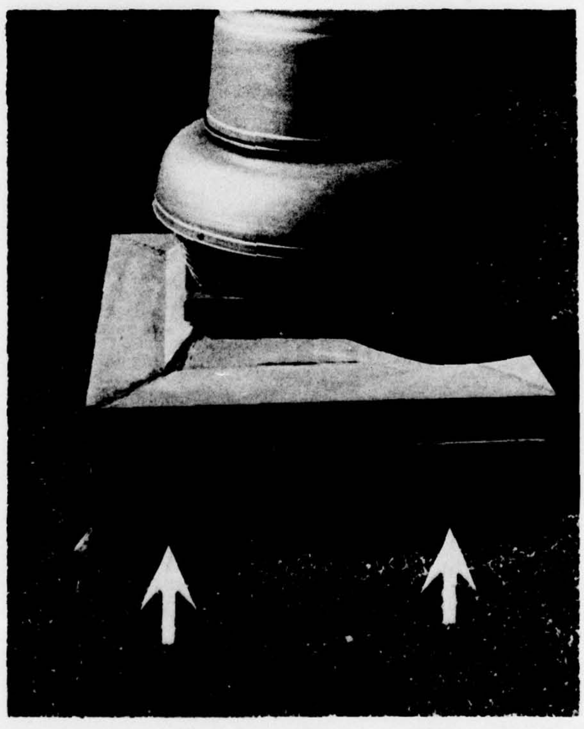


Figure 4. Arrows point to flaws in a vent flashing, Building 116.

** Water contents in this report are expressed as the weight ratios of water to dry insulation.*

Figure 5. Arrows point to flashing flaws at the firewall, Building 116.

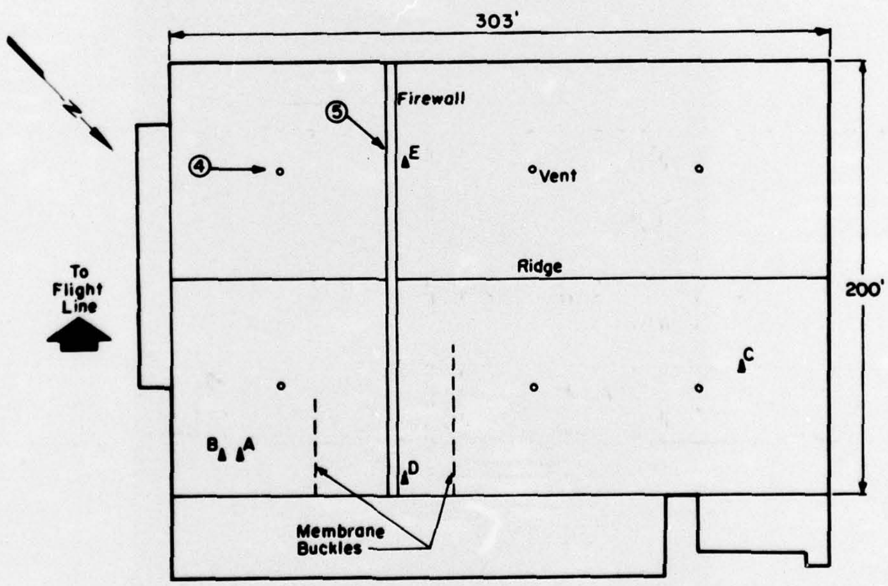


Figure 6. Plan view of roof of Building 116. The water content of the insulation at samples A, B and C (taken in Sept 1975) was essentially 0. Samples D and E were taken by WES in 1975. Sample D was dry, but some moisture was detected in sample E. Arrows indicate the viewing direction and location of subjects in Figures 4 and 5.

The main roof is subdivided by a masonry firewall. The firewall flashing is split in several places, as shown in Figure 5. A plan view of this roof is shown in Figure 6. The main roof consists of a gypsum deck, 1½ in. of glass fiber insulation, and a gravel-covered built-up membrane about ⅜ in. thick. A ridge runs the long dimension of the main roof at its centerline. From the ridge the roof slopes noticeably to its eaves. Internal drains are located near the eaves. The smaller roofs are lower than the main roof and are essentially flat.

Building 116 was surveyed on two separate occasions: 10 September 1975 and 14 October 1976. A few faint anomalies were detected in 1975. They were sampled where shown in Figure 6. Each of samples A, B and C had a water content of 0%. Samples D and E were taken by WES in 1975. Sample D was dry, but a small amount of moisture was detected in sample E. The 1976 resurvey indicated that no new anomalies had developed since 1975.

Although no wet insulation was detected with the infrared camera, the roof is deteriorating. Steps should be taken to correct the above-mentioned roof deficiencies before water finds its way into the insulation, necessitating expensive repairs.

BUILDING 122
(Base Supply Warehouse)

The large roof of this building is divided into four bays by masonry firewalls, as shown in Figure 7. The two middle bays each have two

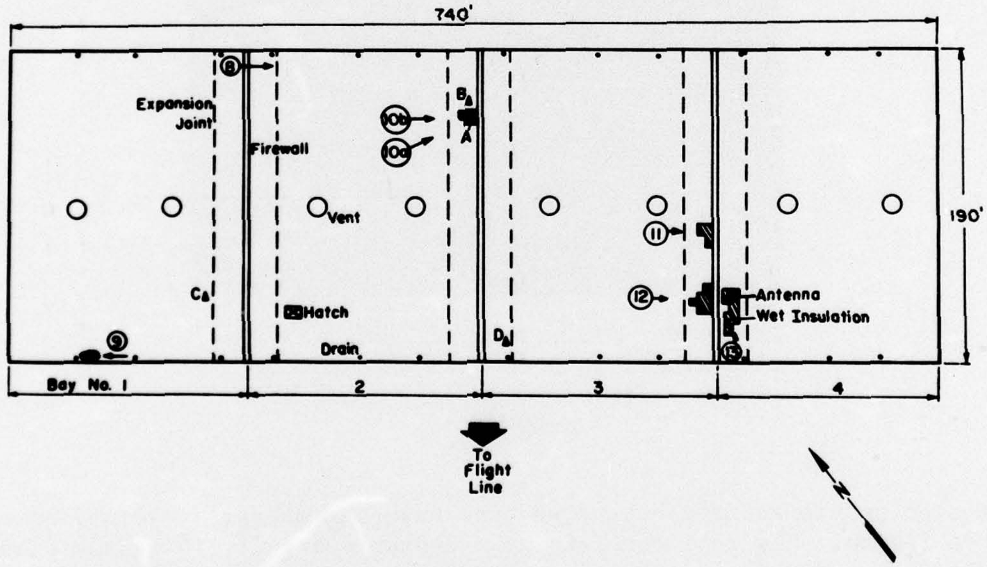


Figure 7. Plan view of Building 122. The insulation of samples A and B had water contents of 318% and 0%, respectively. Samples C and D, taken by WES in 1975, were both dry. The arrows point to the viewing direction and location of subjects in Figures 8-13. Wet areas have been outlined in white spray paint on the roof.

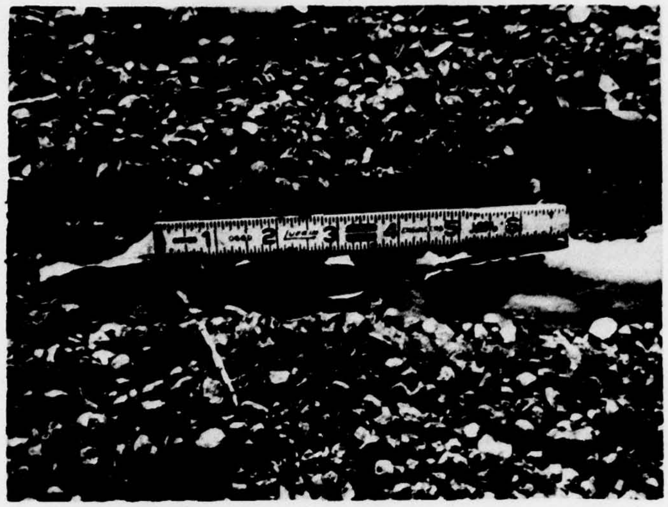
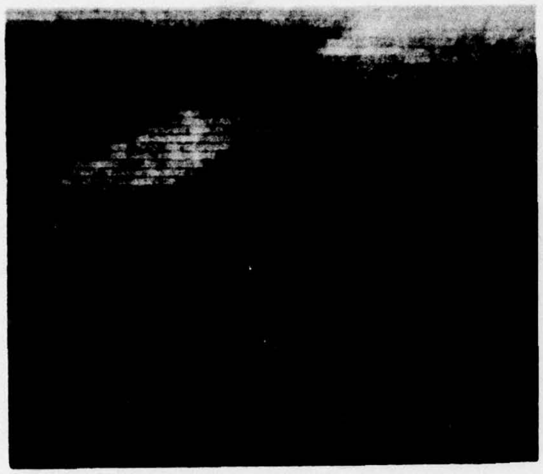


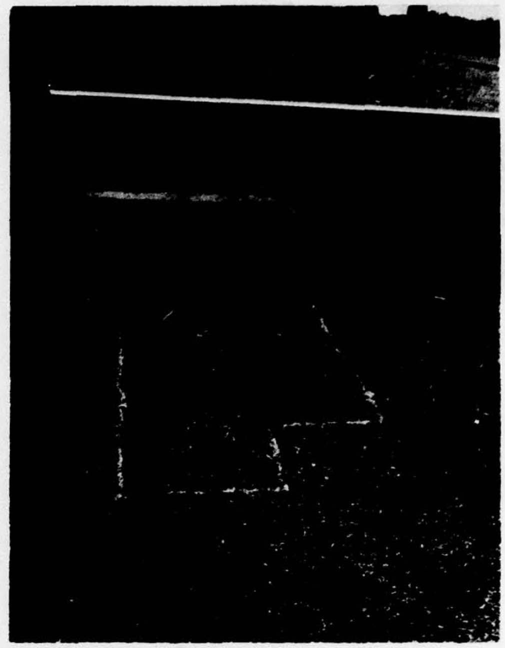
Figure 8. Crack in hammered-down expansion joint, bay 2, Building 122.

Figure 9. Area in bay 1, Building 122, that showed up bright in the infrared camera. Its boundary was marked with spray paint.

expansion joints and the outer two bays have one expansion joint, as shown in the figure. The roof consists of a gypsum deck, $1\frac{3}{4}$-in. glass fiber insulation, and a $\frac{3}{8}$-in.-thick gravel-coated built-up membrane. The membrane is badly blistered over the entire roof. Felt flashings at the firewall are dried and cracked. The ends of the metal expansion joints had been hammered down onto the roof to facilitate drainage of ponded water. At one such location a sizeable crack was present in the expansion joint (Fig. 8).



a. *Nighttime thermogram. (See Fig. 7 for viewing direction.)*



b. *Daytime photograph. (See Fig. 7 for viewing direction.)*

Figure 10. Area in bay 2, Building 122, that contained wet insulation. A sample within the spray-painted boundary had a water content of 318%, while a sample taken outside the boundary was dry.

The overall thermal appearance of the roof when viewed with the infrared camera was good. However, five small moisture-caused anomalies were detected. They are cross-hatched on Figure 7. The perimeter of each anomaly was marked with white spray paint for future reference. The anomaly marked in bay 1 is shown in Figure 9. Water quite likely entered this area through a flaw in the membrane at the vent penetration or at the drain shown in Figure 9.

A conventional photograph and a thermogram of the anomaly in bay 2 are presented in Figure 10. Flaws in the firewall flashing are quite likely responsible for this problem. Similar flaws probably are also responsible for the two wet areas detected in bay 3 (Fig. 11 and 12). Samples A and B were taken inside and outside of the bay 2 anomaly to verify that wet insulation was present. The insulation outside the anomaly was dry (water content 0%). Within the anomaly a water content of 318% was measured. Samples C and D were taken by WES as shown in Figure 7. They were both dry. A photograph and thermogram of the bay 4 anomaly are presented in Figure 13. The wet area was located at a TV antenna at the base of which a hole had been drilled through the roof to permit access for the antenna wire.

Flaws associated with the five wet areas on this roof should be repaired as soon as possible. Since the areas are small, the thermal implications of leaving the wet insulation in place are also small. If the roof membrane were not blistered it would be suggested that the five

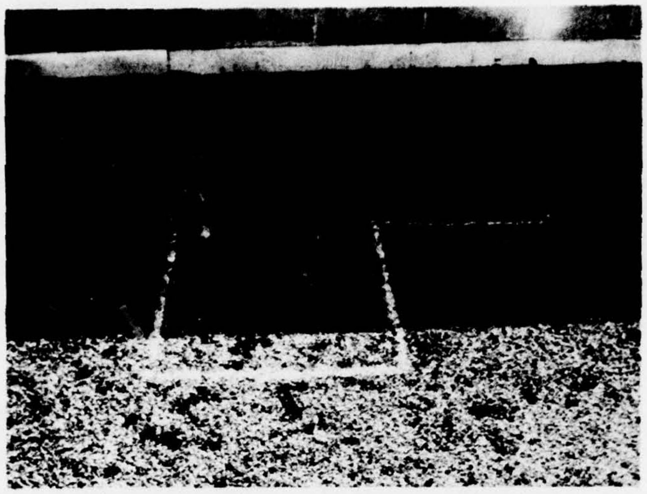


Figure 11. One of two spray-painted anomalies in bay 3, Building 122.

Figure 12. Second spray-painted anomaly in bay 3, Building 122.

small wet areas be cut out and replaced with dry insulation and a new membrane. However, since the entire roof is covered with blisters and will probably not last more than 5 years, the need to remove the insulation from the five small wet areas is questioned.

Blisters are bad and they will progressively worsen, but since this roof is not full of water and does not leak badly, it may be premature to remove the membrane and insulation. It would seem prudent to wait until the membrane fails (as opposed to blisters) before spending several thousand dollars for a replacement. With the infrared camera, deterioration can be monitored and little problems (such as the five wet areas

a. Thermogram.

b. Photograph.

Figure 13. The anomaly in bay 4, Building 122, at the base of the TV antenna. A hole had been drilled through the roof to allow the antenna wire to enter the building. The hole was not plugged above the deck.

discussed above) can be "nipped in the bud," thereby increasing roof life economically without significantly increasing the risk of serious leaks.

BUILDING 205
(Alert Building)

A plan view of the roof of this building is presented in Figure 14. Lieutenant Mike Suflita of the Base Civil Engineering Division accompanied CRREL personnel on this survey and requested that no samples be taken on this roof. Consequently, details such as the type and thickness of the membrane and insulation are unknown.

Several anomalies were detected with the infrared camera. All but one were traced to mounds of gravel up to 3 in. deep on the roof. The one anomaly not associated with a gravel mound was on the northwest low roof. Although no samples were permitted on this roof, there can be reasonable confidence that the area cross-hatched in Figure 14 contains wet insulation. However, insulation in the cross-hatched area in Figure 14 should be sampled to verify the infrared findings. Since the wet area is quite large, it is suggested that the membrane and insulation be removed and replaced over the entire northwest low roof.

The other three low roofs of this building have some perimeter flashing problems which should be resolved to prevent these roofs from suffering the same fate as the northwest low roof.

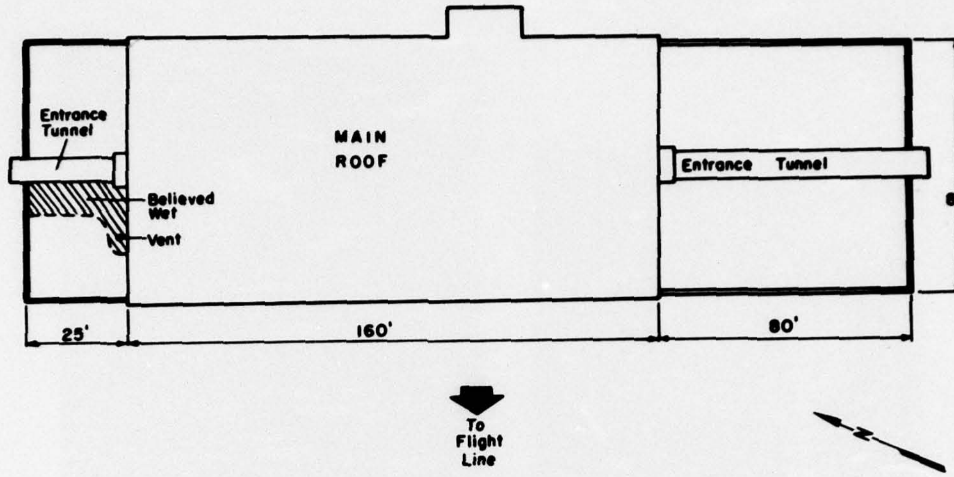


Figure 14. Plan view of Building 205. The main roof is one story high while the four side roofs are about 2 ft below ground level. They are separated from the ground by a perimeter wall which projects a few inches above grade.

CONCLUSIONS AND RECOMMENDATIONS

Although the patched and overcoated roof of *Building 33* is visually in poor shape, the insulation appears to be dry over most of the roof. The leaks are probably associated with flashing flaws. Perhaps another attempt should be made to prevent leaks, but this time flashing repairs should be made rather than flood-coating the entire roof. If leaks persist, all the insulation and built-up membrane on this small roof should be removed and replaced.

The roof of *Building 116* is in fairly good condition. It does not need replacement, but comprehensive repair of flashings is required to prevent rapid deterioration.

The roof of *Building 122* contains five small wet areas. The penetrations and flashing flaws associated with each wet area should be repaired, but because of the age and condition of the roof, it does not seem necessary to remove the wet insulation and replace it with dry insulation and a new membrane in those small areas. Because the membrane is badly blistered, a new roof will probably be required within five years. However, since most of the insulation is dry and leaks are not a problem, it seems premature to replace all the insulation and the membrane at this time. Annual checks with the infrared camera are recommended.

A large portion of the northwest low roof of *Building 205* is expected to contain wet insulation. Replacement of the northwest low roof seems justified. However, a sample should be taken there before contracting for replacement of the insulation and membrane to verify infrared findings. Perimeter flashings and other penetrations should be comprehensively repaired on the other three low roofs.